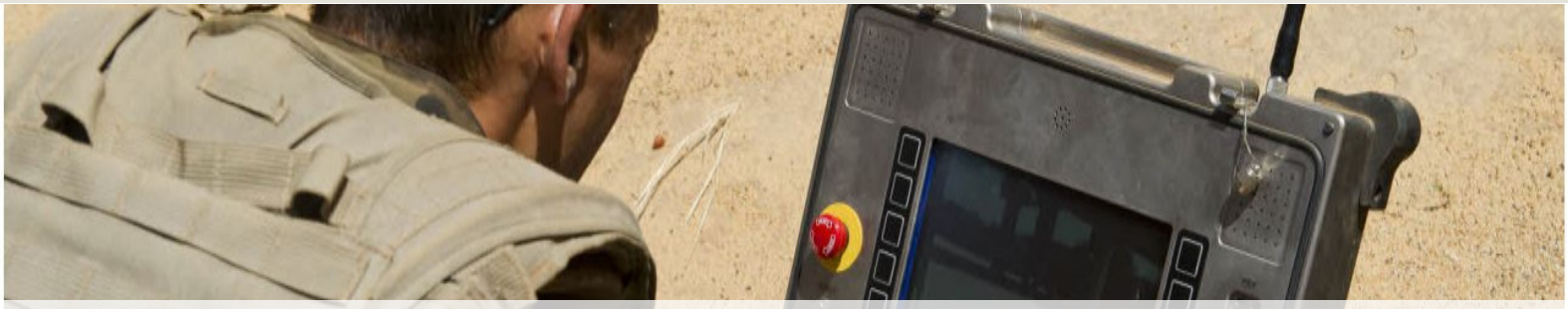

The challenges of infovalorisation: What information systems for tomorrow?

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In a dynamic of general infovalorization of our society and our armies, battalion commander Franck Duchemin, commander Jérôme Cheyppe and captain Jean-François Caverne show what place and dimensions to give to the systems of the armed forces.What place and dimensions should be given to current and future information systems in our military structure with its own specificities, taking care that they remain an advantage and not a constraint for the operational effectiveness of our land forces?

In his book "AchtungPanzer", General Heinz Guderian combines the possibilities of transmissions with the missions of a horse-free cavalry. The use of the radio, present in all Panzerdivision vehicles, combined with command by objective, was a decisive factor of success during the Battle of France. This innovation enabled the appearance of advanced mobile command posts that speeded up the distribution of orders and reports, and ultimately ensured greater responsiveness than that of the Allies, who were still using wired telephones and written orders on paper. Today, technological innovations in the field of information systems are dazzling in terms of the prospects they offer and the pace of technological change they impose.

In a dynamic of general info-enhancement of our society and our armies, what place and dimension should be given to current information systems and to in our military structure with its own specificities, taking care that they remain an advantage and not a constraint for the operational effectiveness of our land forces.

An information system will be understood here as an organised system of resources (hardware, software, personnel, data and procedures) enabling information to be collected, stored and disseminated [1]. 1] Info-use is the optimal use of information resources enabled by new technologies to improve operational effectiveness. The approach of this thesis is to imagine the post-SCORPION information system [2].

As a determining factor for success, the choice of the information system requires, above all, prospective and conceptual work in order to bring the force structure, doctrine and

the possibilities offered by technology into line, thus enabling the decision to be taken with greater freedom of action, greater flexibility and more agile combat.

On the basis of the pragmatic observation that the need for information is invariant in battle, it is necessary today to discern the importance of information systems in theatres of operation. Next, it is necessary to understand the challenges of infovalorisation, a key stage in the digital transformation of land forces. Finally, it is necessary to look ahead and understand the extent to which this emerging technology, once mature, could be the determining and unavoidable factor in operational effectiveness.

Lifting the fog of war: an unchanging need for information

In the mid-1990s, digitization was defined as the process of converting content on analog media into digital data that can be used by information and communication technologies. This dematerialization has affected all spheres of our society, including the military world, for which these technologies have caused a veritable information tsunami. Increasingly and irreversibly, these tools have imposed themselves in the battle space, and have enabled the birth of the SIOC [3]. [3] The latter made the digitization of operations possible by seeking to increase efficiency in the preparation of decisions and the coordination of actions.

- A definite added value

Recent conflicts are rich in lessons concerning the digitisation of operations, in particular during the Gulf War with the American experience of the FBCB2 [4]. Under the impetus of the RMA[5], the United States proved (Kosovo in 1999, Iraq in 2003) that this instrument, which is still in use, has had an irreversible and sometimes unpredictable influence on the art of command and the use of forces. In Western forces, this digitisation has enabled the emergence and development of collective action thanks to a global digital reference allowing the coherence of individual operational actions. This digitisation has revolutionised training and education methods, as well as the culture of command.

Without being an end in itself, the NEB is a decision support tool for knowing, understanding and acting more quickly and effectively than the adversary [6]. 6] The NEB is divided into several IS according to the level of employment: SIT at section level; SIR at regimental level; SICF at staff level.

The NEB makes it possible to have immediately, either on simple request or by automatic synchronization, a common and updated cartography of the battle space.

- An unfinished process

France, like its allies, has increased its operational efficiency by mapping, geo-referencing, geo-locating mobile objects [8]. The 2000s saw the emergence of huge databases and bandwidth requirements that current technologies have difficulty managing. Low interoperability, low data rates [9] and the high level of expertise required for administration have allowed informational chaos to set in, thus constituting real youthful defects of the NEB.

- Time for change: the emergence of infovalorization

As a result of the work carried out in the framework of the BOA [10] 2005-2012 programme [10], infovalorisation is one of the ambitions for future land forces [11]. 11] It is defined there as "the optimal exploitation of information resources authorised by new technologies to improve the effectiveness of air-land forces in engagements". It aims to complement the NEB's "doing better" with "doing differently" through technological innovations.

The SCORPION programme's infovalorisation aims at operational superiority through integration up to the SICS regimental level [12]. This standardisation is intended to be intuitive and reactive in order to optimise contact capabilities and win the support of the military and, above all, to improve the synergy between the various operational functions. Linked to the SICS, the vetronics will capture all the information (alert, targeting, navigation, etc.) to share it in an operational matrix designating objectives by any platform of the network while optimising the reactivity of joint or even joint support. Moreover, the integration of simulation into the system will allow platforms to be trained in a realistic context.

The stakes of infovalorization

Going beyond the simple renewal of current digitisation capacities, the infovalorisation and choice of tomorrow's information systems are major challenges for the French Army in the context of its operational commitments. The security and resilience of information systems is a fundamental prerequisite for the development of the benefits derived from infovalorization. An excellent mastery of information management would allow for greater tactical and even operational freedom of action and provide the French Army with the opportunity to envisage a new operational organisation of land forces. However, each evolution carries its risks. An unthinking adoption of tomorrow's IS could run counter to the gains mentioned above and lead to a loss of value compared with the current situation.

- Resilience

The technological advance of Western armies has given them new weaknesses. IS, like other "techno-systems", will therefore be condemned to be attacked or bypassed. Since infovalorization relies on them, resilience is a challenge to be met [13]. This refers to the capacity to absorb partial disruptions or destruction without altering the overall functioning of the system.

Meeting this challenge implies designing an IS with an acceptable level of faults that can be corrected over its lifetime, but also with a certain rusticity to cope with the hostility and abrasiveness of the environment. This resilience is achieved by the consistency and robustness of the entire IT platform ? vehicles, command posts, landed equipment, etc. ? with the entire environment necessary for the operation of the IT system. This platform has "vital" needs such as, for example, the permanence of a power source, air conditioning, securing software vulnerabilities, limiting human intervention, etc. Tomorrow's IS will therefore be those that have been developed to meet operational needs and will take into account resilience factors, thus ensuring continuity of command. Nevertheless, it will be important for IS to be able to operate in degraded mode after a cyber-incident and to combat the evaporation of fundamental know-how that does not require the use of digital tools.

- Freedom of action

The second challenge of infovalorization and tomorrow's information systems concerns the freedom of action of the force. This could be reinforced by geolocation, which would help to dispel the "fog of war" and accelerate the pace of operations. On the other hand, major risks linked to the capacity to process information could negate or even outweigh these benefits.

The automated reporting of the positions of all friendly and neutral units and estimated enemy positions gives the military commander an accurate view of the tactical situation. This would then be shared by all friendly forces, reducing friction and significantly increasing joint and combined arms coordination. This better awareness of the environment would make it easier to be daring, to take the initiative and to adjust resources rapidly to changing circumstances, thus ultimately enhancing freedom of action. The instantaneous localization of each unit would thus make it possible to partially lift the fog of war", but its complete lifting would remain only a utopia.

Freedom of action could also be reinforced by an acceleration in the pace of operations obtained during the design and conduct of operations. Sophisticated digital tools, such as simulators for war games (wargame), 3D maps or intuitive graphical tactical editors integrated into IS would provide valuable help in optimising collaborative work within PCs during the design phases, even if the speed of decision-making would not be radically changed.

Precise and instantaneous knowledge of the situation would make it possible to anticipate design work, thus enabling better adaptation to contingency changes. The information would not be limited to location, but to all the parameters (logistics, CIS, intelligence, etc.) that characterise the units engaged in an air-land operation. This omniscience at the upper echelon will help to provide the necessary elements for the effective conduct of operations, for taking decisions in the right tempo, which will enable them to stay one step ahead of the adversary.

Nevertheless, this new production of information carries significant risks of reducing the freedom of action of air-land forces. Indeed, a quantity of poorly disseminated and poorly stored information makes it very difficult to access data. However, the data must be just enough for the optimum functioning of a command post and a fortiori for effective decision-making by a military leader. An overabundance of information could thus slow down or even distort the decision. The leader would find it increasingly difficult to extract himself from all the data transmitted to him in order to take the necessary height of vision. The cognitive pressure that could be exerted on leaders at each level of the hierarchy could lead to paralysis that would run counter to the expected acceleration.

- Organizational plasticity

Thinking about tomorrow's information systems means asking questions about the operational organisation of land forces in general and command in particular. Consequently, the third and perhaps most decisive issue for the future is the organisational plasticity of land forces engaged in operations, i.e. the ability of command structures to adapt their subordinate relationships according to circumstances. A brief analysis of the current organisation is required to determine the tactical opportunity that the new IS can bring, while assessing the risks associated with an insufficiently thought-out choice.

The French Army, like other Western armies, has always been organised in a pyramidal manner. This structure was in particular the consequence of the possibilities offered by the means of communications. It is particularly "partitioned vertically by the sacrosanct limits and horizontally by the successive hierarchical echelons" [14]. Information is thus channelled at each level. However, since the advent of computer networks, mesh structures are technically feasible, which has the enormous advantage of not channelling information. Nevertheless, the current NEB has not been able to match the architecture permitted by the network protocols and the operational organisation of the land forces.

The current command system therefore remains rigid despite digital communication tools. Moreover, the current NEB experience, one of the main assets of which is geolocation, has gradually led to a crushing of levels and a shift from command by objective to quasi-command by order. The higher echelons with a great deal of information on the subordinate levels are thus tempted to carry out the latter's missions when they should only be conducting them.

IS thus have a direct impact on the command culture of an army, which makes it all the more important to reflect on the style of command that the army wishes to adopt in order to choose the appropriate IS.

On the basis of these observations and analyses, ICTs therefore offer the opportunity to achieve a real revolution for the army by shattering the traditional pyramidal structure. Indeed, tomorrow's IS could enable the organisation of the force to be constantly adapted to the changing tactical situation by allowing frequent changes of subordination and the dilution of resources into small elements. This would respond in part to the characteristics of tomorrow's manoeuvre as predicted by General Hubin. The spectrum of risks and opportunities is therefore wide, ranging from the reinforcement of the current rigid, compartmentalised pyramidal system with an increasing "verticalisation" of command to a flexible, malleable and modifiable structure that would allow the development of a command by objective, or even collaborative command in the extreme. Nevertheless, if this challenge is not well perceived, the expected revolution could only be a simple evolution of equipment.

Limiting friction[15]: the challenge of 21st century IS

- Information accessible to all: the battle**cloud**

In order to be able to share and make the best use of an ever-increasing volume of information, the armed forces must equip themselves with a network that is sized and capable of supporting their exchanges. The control of bandwidth and the processing power of the flows are essential in the face of the growing number of sensors and increasingly large files. Beyond that, the network must be able to operate in an austere environment where infrastructures and access to energy cannot beIn addition, this network must be able to operate in an austere environment where infrastructures and access to energy cannot be guaranteed, and where congestion and complexity are hardly compatible with modern operating methods where the objective is to reduce weight.

One of the technological solutions that can meet this challenge is the "combat cloud". This is an on-demand access service, offering users automatic access to resources with limited expert intervention. This network access must be able to use large bandwidths with immediate reactivity, supporting heterogeneous platforms (PCs, touch tablets,

smartphones) and interoperable in the context of multinational missions. Several armies are already working on these systems, in particular the US Army and especially the Marine Corps [16].

A "combat cloud" on national territory is easy to set up because it will be based on a controlled technical infrastructure and environment. This is obviously not the case in the context of a deployment in an external theatre where, very often, the infrastructure is non-existent or insufficient. One solution would be the use of stationary high-altitude balloons allowing a wide coverage of the entire area of action. This would be a complementary and economical solution to the capacities offered by satellites. In more urban theatres, the reuse of existing infrastructure or the deployment of heavy or portable military relays would provide access to the combat cloud.

However, this cloud should not burden troops with additional equipment or generate energy requirements and therefore constitute a new constraint for the logistics chain. To do this, this virtual resource must be shared with a physical resource existing on the battlefield. This could be implemented on an existing platform of a vehicle or command post that is sufficiently dimensioned from a CIS point of view.

Today, information storage is based on a distributed logic. However, the "combat cloud" is based on a centralized logic. The solution for the armed forces is to implement a hybrid system, thus ensuring greater resilience while preserving the efficiency of the system. Indeed, in order to prevent the total loss of the tactical advantage offered by the "combat cloud" in theevent of network unavailability, it is also necessary for the units tos deployed units must have storage facilities that are sufficiently large to guarantee that troops can operate with the latest tactical vision in buffer memory. When reconnecting to the network, a dynamic resynchronisation method must guarantee that the system is kept up to date.

The chain of command will also be concerned by the installation of a "combat cloud" which brings together all information and its processing in a single point. Because of the ability to disseminate information both vertically and horizontally throughout the chain of command, it will be imperative to limit "double decision blocking", i.e.-Because of the ability to disseminate information both vertically and horizontally throughout the chain of command, it will be imperative to limit the "double decision block", i.e. not to see "a command taking decisions only after having [had] as much information as possible, and [...] subordinates too busy being accountable to take effective tactical action" [17].

17] [17] Awell-controlled "combat cloud" provides a major advantage to the forces, but it can quickly become a priority objective of the enemy. Whether through cyber attack means or simply effective jamming, the enemy's priority will be to disrupt the use of the cloud. In the face of these threats, the system must be developed with a capacity for resilience to which technical "shields" and experts can be added. Vertically partitioned systems, i.e. systems that are not too interdependent, could help to mitigate the risks associated with cyber-attacks. These infrastructures in operation are also threatened by kinetic attacks and require, in addition to dedicated protection, the implementation of redundancy and real-time replication means to avoid its collapse and the loss of its tactical advantage.

- Convergence of organization, doctrine and IS: for agile combat

Tomorrow's battle will be one where concealment will be difficult and the concentration of forces dangerous or ineffective. Thus, the achievement of tactical surprise, imperative

for any victory, will come from the one who has the best vision of the situation and who will know how to coordinate the action while his opponent is still in doubt. Thus, surprise will no longer be based on physical concealment, which is less and less easy to achieve, but will consist in playing on the time factor and on intentions. This is the very essence of agile combat, in other words, a combat that is flexible, alert, and lively in its maneuver and in its understanding of the situation.

To this end, a convergence of the organization of the force structure, the doctrine and the properties of the selected IS is imperative to obtain the quintessence of the possibilities offered by technology. For, as General Desportes wrote, "inserted in old organizations, used according to concepts that are outdated, new techniques often render only marginal services" [18] [18].

In order to ensure coherence between the organisation, doctrine and IS, it would be necessary to distinguish three levels: execution, conduct and design. Since IS needs are not the same at each level, they must be properly analysed and identified.

- The execution level: collaborative combat

This execution level corresponds to the section or platoon. Made up of three to four maneuver counters, it is placed under the orders of a leader who will know how to maneuver by making optimal use of the terrain and his weapons to destroy his opponent. The contribution of information systems at this level is to enable combat to be more collaborative.

Collaborative combat will be understood here as the sharing of information with the "community of interest", i.e. friendly elements in the close vicinity ensuring immediate reactivity in the face of a threat. The aim is to enhance the value of information to lighten the cognitive weight of the soldier. It is an aid to action, but not to decision-making. Within the framework of SCORPION, the vetronics of combat vehicles combined with acoustic, laser or missile start detectors ensure reaction and coordination [19]. 19] It is only a matter of assistance, because the sharing of authority must be preserved: decisions to act must remain humane.

The connected soldier must know his position and those of his immediate neighbours at all times, without any notion of spindle limits or unit membership. Thus, the information system must be built as a meshed network structure with a common technical basis for exchange which allows, by a simple request for an invitation to a neighbour, once accepted, to access his information (a "plug and play" logic). This principle should limit fratricidal shooting and will offer the advantage of benefiting from an overview of the action zone by sharing observations. As military history has too often demonstrated, it is always at the junction between two units that the adversary launches his offensive [20].

20] The soldier landed tomorrow will then have to benefit from a light, minimal and effective man-machine interface. The information will have to be limited to friendly and enemy positions, and could possibly have as supports augmented reality goggles or connected type watches. Indeed, the tactical leader will have to concentrate more on the field than on his screen. The information system will have to be adapted to the needs of each person with a basic software package and additional applications on the map. The AUXYLIUM system is the first step towards this physical and cognitive lightening of the landed combatant by arming him with a smartphone secured by an encryption box. It thus opens up the field of hybrid information and communication systems. Indeed, it will be possible for the combatant to benefit either from the civilian 4G network when it is

working or not saturated [21], or from a purely military network. This connected object, in addition to serving as a tactical radio, opens up to the military, in a single device, everything that smartphone technology allows today via specific applications: GPS, image and video transfer, message exchange, videoconferencing, piloting a tactical mini-UAV.

- The driving level: organizing collaborative work

At the driving level, it is a question of coordinating the action of the various pawns at the execution level and combining the effects of each one in order to achieve the objective set by the design level. Attached to the field and receiving the necessary and sufficient information, this level has a global view of the tactical situation and organises its manoeuvre by coordinating fire support and obstacles and by ensuring "the logistical meetings on which the maintenance of the manoeuvre's rhythm, a fundamental element of surprise, will largely depend" [22]. To do this, the commander must have access to all the information from his subordinates (positions, observations, logistics) in order to understand the tactical situation and, thanks to command by objective, seize opportunities to win the decision.

The combat will be much more agile: thanks to the perception of the contours of the enemy and to a real-time knowledge of the friendlies, it will be possible to abandon the limits of coordination and to accept the overlap with the adversary.

The ubiquity of the tactical leader will make it possible to design a non-linear combat and to apply the swarming process, i.e. the "rapid regrouping of units".The ubiquity of the tactical leader will make it possible to design a non-linear combat and to apply the swarming process, i.e., the "rapid regrouping of units of different size and nature on an objective, which penetrate the three dimensions and by divergent access routes, before dispersing just as quickly once their mission is completed" [23]. In the more distant future, the leader will be able to benefit, as a complement, from artificial intelligence to complete his analysis of the situation and thus be effective in his decision.

In permanent liaison with the level of conception and with the different levels of leadership, a true distributed collaborative work will be set up thanks to theIn permanent liaison with the design level and with the different levels of management, a true distributed collaborative work will be set up thanks to information sharing and the video-conference system allowing, at a distance, to participate in the tactical decision making method.

- The design level: lifting the fog of war

The first level of tactical design and structured around a real command post, the design level is the only level with the means to analyse information and a capacity to anticipate future manoeuvres.

Today, it is no longer a question of playing "naval battle", but a real "chess game". To do so, it is necessary both to anticipate moves in advance and to understand the objectives and manoeuvres of the opponent. The objective will be well to enter in the opponent's decision cycle, preventing him to recover his balance by regaining a certain freedom of action. This is General Yakovleff's idea of "syncopated combat" [24], which consists in taking the temporal counterpart of the opponent.

"This can be achieved by an irregular rhythm of execution and, more concretely, by an

unequal phasing of the maneuver, alternating waiting times and lightning flashes" [25]. This requires the ability to process information coming not only from subordinates (conduct and execution), but also from higher levels. The more complete the information, the more reliable the decision. However, when the leader has more information than he can handle at the same time, his decision making is slowed down, even causing hesitation or even a wait-and-see attitude. At this level, mastering information and managing big data becomes a real challenge. To partly remedy this, it is possible to supplement decision making with artificial intelligence to process, structure and deliver reliable information on time and at the right time, in addition to human analysis.

At the logistical level, perfect knowledge of the status of friendly forces can help to develop the line of operation concept. Breaking with existing logistic schemes, three-dimensional printing technologies could become a complementary solution to the optimization of maintenance in operational condition (MCO). "The rear will always supply the front, but noria will replace pulsation, flows will replace pre-positioning and responses will replace anticipation" [26].

Thus, it is necessary for the army not to transfer civilian technology to the military world without first having identified its real tactical and technical needs. "The real turning point in the process of emergence of a technology is not the day of its birth or the date of its introduction on the battlefield, but rather the moment when military thinking changes in order to take into account and optimise its use" [27]. 27] IS offers a real opportunity to renew the overly axial tactics and the overly pyramidal organizational structure of our units.

- Thinking differently about military industrial programmes in the field of IS

The tempo imposed by technological developments in the field of IS is so rapid that it is today incompatible with the pace of armament programmes in this field. Moore's law shows that computing power increases exponentially. At the same time, innovations and even civil technological revolutions are constantly multiplying. The SICS is designed according to the agile method [28], but when it will be in units, it will already be outdated compared to civilian technological capabilities. A paradigm shift in military industrial design procedures and methods is therefore necessary to make SICS evolve continuously.

Given that investment budgets do not allow the updating of this equipment at the same speed as its evolution, it would be wise to ask industrialists to provide infrastructure as a service, its operation and, as a priority, its maintenance in operational condition rather than investing in a complete programme. In particular, ISAF[29] has outsourced to a private company the provision of information and communication networks, their operation and maintenance at more than 64 sites in Afghanistan.

It is up to the Army to guide the industry on its IS needs. As General Beaufre points out, "it is the strategy that must guide inventors or at least choose among inventions those that best meet the needs of the strategy" [30].

Information systems offer us unlimited potential in their applications for the benefit of defense. The first steps of digitisation at the end of the 20th century have enabled us to draw lessons that offer, at the beginning of the 21st century, the entry into a second era. The army that will be able to make the most of information will undoubtedly be ahead of its

adversaries because it will be more agile, able to act more quickly despite the frictions of war. To this end, it will have to adapt its command structures, its doctrine, and change the paradigm of military industrial programmes to optimise the possibilities offered by information systems.

However, information systems have limiting factors. First of all, they are dependent on geolocation. Secondly, they are limited by the quality of communication systems, particularly in terms of throughput and range. Finally, the cognitive pressure exerted on humans by information overload and the non-adherence to the use of an overly complex IS could prevent them from reaping the expected dividends. These three factors are all lines of research to exploit the full capabilities of IS.

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3] Operational information and communication systems

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6] "The Digitization of the Battlespace (NEB)", Doctrine, Tactics, Revue d' information et de réflexion numéro 27, 2013

7] Terminal Information System, Regimental Information System and Force Command Information System

8] United States: FBCB2; United Kingdom: Bowman, ComBAT; Germany: FüinfoSys H .

9] Ratio of one to twenty megabits between PR4G and the home Internet box

10] Air-land operational bubble

11] Future Land Force 2025, TSS, 2005.

12] Scorpio information and communication system

13] Army CIS Symposium, 2015

14] G. Hubin, "Perspectivestactiques", Economica, 2000. (Editor's note: It should be considered here that vertically, the partitioning exists between two distinct hierarchical chains, and that horizontally, communication is often difficult or forbidden between two identical levels).

15] According to Carl von Clausewitz in De la Guerre, "Friction, or at least what we call it, is what makes what seems easy difficult."

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17] R. Hemez, "L'avenir de la surprise tactique à l'heure de la numérisation", Focus stratégique n°69, July 2016, p27

[18] V. Desportes, "Laguerre probable" , Economica, 2007.

19] The turret rallies on the objective, or proposes to launch the smoke.

20] SEDAN's breakthrough in 1940

21] In the context of Operation Sentinel, an attack inevitably leads to the saturation of civilian 4G. A military-to-centric network ensures the continued coordination and exchange of information in such situations. Similarly, in the case of combat in urban areas during an external operation where radio systems are hampered by buildings, the 4G system can be an alternative network that can be reinforced by antennas on vehicles

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26] G. Hubin, "Perspectivestactiques", Economica, 2000.

27] R. Hemez, "L'avenir de la surprise tactique à l'heure de la numérisation", Focus stratégique n°69, July 2016, p29

28] The agile method is an iterative process between the customer and the manufacturer. In other words, it is a construction in small steps.

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Interviews:

- Thursday 29 September 2016: interview with STAT officers: Lieutenant-Colonel Nicolas Chaligne (SICS programme officer); Battalion Chief Guillaume DUFAY (contactization officer)
- Thursday, November 11, 2016: interview with members of THALES: General Gérard Lapprend (Trade France); Mr. Eric DURIEZ (Head of Marketing & Sales Defence and Government); Mr. Didier Bonnerot (Director of Defence Information System SID)

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